Title: Screening potato varieties commonly grown by organic farmers for susceptibility to damage and yield reduction caused by potato leafhopper

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Introduction

A previous study showed that yields of the potato variety "Superior" on organic farms are significantly lower than those on conventional farms, and that lower yields were correlated with higher populations of potato leafhopper. Potato leafhopper feeding causes a physiological response in susceptible plants that reduces photosynthetic capacity and yield. In this study we determined the susceptibility of ten potato varieties commonly grown by organic farmers and two lines developed by the Cornell potato breeding program known to be resistant to damage and yield loss from potato leafhopper. We found a range of susceptibilities in the varieties commonly grown by organic farmers, with some nearly as resistant as the known resistant varieties. This research provides useful information for organic potato growers and is the first step in a long-term project to determine if planting mixtures of susceptible and resistant potatoes can alter leafhopper behavior and protect susceptible varieties from damage and yield reduction.

Objectives/Performance Targets

Determine the susceptibility of ten potato varieties commonly grown on organic farms to damage and yield reduction caused by potato leafhopper.

Materials and Methods

To determine which varieties to include in the trial, we surveyed organic potato growers in the northeast and found that the ten most commonly grown varieties are:

1) Yukon Gold
2) Carola
3) Red Norland
4) All Blue
5) Kennebec
6) Russian Bannana
7) Butte
8) All Red
9) French Fingerling
10) Rose Gold

Andy Leed, our grower team member, was especially interested in looking at the variety Caribe, which ranked thirteenth in the survey, so it was substituted for Rose Gold. Several varieties including Caribe, German Butterball, Red Dale, and Russet had rankings similar to Rose Gold in the survey. Unfortunately, the Caribe seed arrived in poor condition and decayed during suberization so the variety Elba was substituted in the trial. The Elba seed was generously donated by Paul Schafer, a certified seed grower in New York. Elba was of interest because it is a commercially available variety

with good tolerance to potato leafhopper and partial resistance to late blight. The other resistant varieties planted were Prince Hairy, a variety released by the Cornell potato breeding program, and NY-131, the most advanced leafhopper resistant unreleased clone in the Cornell breeding program. State certified, conventionally-grown seed was used for the trial, with the exception of Prince Hairy and NY-131, which were supplied by the Cornell potato breeding program. The following varieties were included in the trial:

Yukon Gold	Butte
Carola	All Red
Red Norland	French Fingerling
All Blue	Elba
Kennebec	Prince Hairy
Russian Bannana	NY-131

The trial was planted on June 7, the earliest date the soil was dry enough for tillage and planting. Each variety was planted in four-row by 20 ft. plots in a randomized complete block design. This plot size had to be reduced from our proposed plot size of 7 rows by 20 ft. because half the area planned for the trial remained too wet to till in early June and it was important to get the trial planted at that point to avoid missing potato leafhopper colonization when nearby alfalfa was cut.

Rows were 34 inches apart and seed pieces were placed 10 inches apart in the row. Ten feet of tilled ground surrounded each plot. Sencor was used for weed control in the plots, and weeds were controlled by cultivation in the area surrounding the plots. Four blocks were treated with Admire 4F at a rate of 1.3 oz per 1000 row ft. to provide season long control of potato leafhopper, and four blocks were left untreated so that each variety/treatment combination was replicated four times.

The fungicides Bravo or Penncozeb were applied to all plots for late blight control at weekly intervals starting August 3. Potato leafhopper samples were conducted July 29, and August 5, 12, and 19. Hopperburn ratings and nymph counts were conducted on all dates. Adults were sampled only on August 19.

Plots were visually rated for hopperburn on a 1-4 scale:

1 Little or no leaf curling
2 Moderate leaf curling plus some leaf necrosis
3 Severe leaf curling accompanied by leaf necrosis
4 Most lower leaves necrotic and/or dead

Nymphs were counted on five leaves from each inside row. Adults were sampled using a sweep net; sweeping 10 passes over each of the two outside rows. Admire treated plots were checked for leafhopper adults and nymphs throughout the season, but none were found.

The trial was vine-killed on August 25 and the inner two rows were dug on September 15. All potatoes from the inner two rows each plot were weighed for yield estimates.

Accomplishments/Results and Discussion/Milestones

The 2004 season was characterized by copious amounts of rain, with 6.25 inches falling in May followed by a total 13.5 inches in June, July, and August. Standing water persisted in some plots throughout the season. Yield estimates from five severely affected plots were discarded and values were estimated based on the average of the remaining plots of that variety/treatment. Because of the water-induced stress, and general lack of warmth and sunlight, yields reported below do not represent the yield potential for any of these varieties. Only differences between the treated and untreated plots are of interest. Yield data for treated and untreated plots was compared using a T test (Proc TTEST, SAS Institute). Table 1 shows the average yields for the treated and untreated plots, the percent reduction in the untreated plots, and the probability values for a T test comparing treated and untreated yields. Varieties are listed in order of greatest to smallest reduction in yield in the untreated plots. Differences between treated and untreated plots for which the probability values are less than or equal to .05 are considered to be statistically different. Yields of All Blue, Carola, Kennebec, and Butte

in the untreated plots ranged between 37 and 65% lower than the treated plots, and differences between treated and untreated plots are statistically significant. Red Norland and French Fingerling experienced similar reductions in yield but were differences were not statistically significant. Russian Banana, Elba, Yukon Gold, Prince Hairy and All Red experienced intermediate yield reductions ranging between 9 and 21%, but again, differences were not statistically significant. NY-131 experienced no yield reduction in the untreated plots.

Table 1

	Average Yield (lbs./ 40 row ft.)			
Clone	**Untreated**	**Treated**	**% Reduction**	**Prob > T***
All Blue	8.4	24.1	65.1	0.0008
Carola	16.6	35.3	53.0	0.006
Kennebec	23.9	38.8	38.4	0.02
Red Norland	21.1	34.2	38.3	0.09
Butte	29.3	46.3	36.7	0.03
French Fingerling	20.8	32.8	36.6	0.08
Russian Banana	35	44	20.5	0.25
Elba	31.4	38.3	18.0	0.33
Yukon Gold	36.1	40.6	11.1	0.44
Prince Hairy	44.8	49.9	10.2	0.5
All Red	49.3	54.3	9.2	0.43
NY 131	36.1	35.9	-0.6	0.95

*for t test comparing yields for untreated (no Admire) and Admire treated plots

Leafhopper nymph and adult counts, and hopperburn ratings were analyzed using analysis of variance (PROC ANOVA, SAS Institute), and means were separated using the Least Significant Difference procedure. In Tables 2-4 means followed by the same letter are not significantly different.

Because of the late planting date, the trial was not subject to the first wave of adult leafhopper immigration, and leafhopper levels remained moderate throughout the season. Kennebec, Red Norland, and Carola supported the highest levels of leafhopper nymphs (Table 2), which were significantly higher than those on NY-131, French Fingerling, Prince Hairy, Elba, and Butte.

Table 2.

Kennebec	6.0	a
Red Norland	5.9	a
Carola	5.1	ab
All Blue	3.9	abc
All Red	3.6	bc
Yukon Gold	3.5	bc
Russian Banana	3.4	bc
NY 131	2.6	c
French Fingerling	2.6	c
Prince Hairy	2.0	c
Elba	1.9	c
Butte	1.6	c

LSD means separation for seasonal mean number of potato leafhopper nymphs/10 leaves. Pr > F for anova = .0017

In the single sample of leafhopper adults (Table 3), the highest levels were found on Russian Banana, and were significantly lower on Yukon Gold, Prince Hairy, Butte, NY-131, and Elba.

Table 3.

Russian Banana	8.5	a
All Blue	7.8	ab
Kennebec	7.8	ab
French Fingerling	7.8	ab
Red Norland	7.5	ab
Carola	6.5	ab
All Red	4.5	abc
Yukon Gold	4.0	bc
Prince Hairy	3.8	bc
Butte	3.8	bc
NY 131	3.8	bc
Elba	1.8	c

LSD means separation for single PLH adult sample. Pr > F for anova = .03

Hopperburn ratings (Table 4) on Carola and Red Norland were highest, with ratings on Kennebec, French Fingerling, Prince Hairy, Yukon Gold, and Elba significantly lower.

Table 4.

Carola	2.3	a
Red Norland	2.3	ab
All Blue	2.1	abc
Russian Banana	2.1	abc
NY 131	2.0	bc
Butte	2.0	bc
All Red	2.0	bc
Kennebec	1.9	c
French Fingerling	1.9	cd
Prince Hairy	1.6	de
Yukon Gold	1.6	de
Elba	1.5	e

LSD means separation for seasonal mean hopperburn ratings. Pr > F for anova = .0001

Yield reductions caused by potato leafhopper on a particular potato variety reflect a combination of the attractiveness of the variety to leafhopper adults, the reproductive success of the adults that colonize the crop, the fitness of the foliage as a food source and habitat for nymphs, and the susceptibility of the variety to the physiological effects of leafhopper adult and nymphal feeding. One goal of this study was to provide organic potato growers with information about their commonly grown potato varieties. Carola, Red Norland, All Blue, and Kennebec stand out in this trial as highly attractive to leafhoppers and susceptible to hopperburn and yield reduction. Russian Banana, Elba, Yukon Gold, Prince Hairy, and All Red did not experience significant yield losses in untreated plots, although their leafhopper

population levels and hopperburn ratings were variable. Reliable conclusions about these varieties will require a repeat of the trial, hopefully in a warmer, drier year with more leafhopper pressure.

Another goal of this study was to identify varieties for use in future trials examining the potential for planted mixtures of leafhopper resistant and susceptible varieties to alter leafhopper behavior and protect susceptible varieties from damage. This study has identified Red Norland as an attractive, susceptible variety and confirmed NY-131 as unattractive and resistant and we will proceed with those varieties in future trials. Elba also stands out as a resistant, unattractive variety, but because it is a very long season variety, it would be best paired with a long-season susceptible variety.

Impacts and Contributions/Outcomes

The results of this trial will be made available to organic farmers and extension colleagues in newsletter articles. Hopefully it organic farmers will include some tolerant varieties in their mix to minimize the chances of serious yield reduction in years with high leafhopper pressure.

Areas Needing Further Study

While this study identified potato varieties commonly grown by organic farmers with tolerance to damage from potato leafhopper, it does not fully address the issue of potato leafhopper control on organic farms. We will be seeking funding for studies looking at the potential for planted mixtures of susceptible and resistant varieties to alter leafhopper behavior and protect the susceptible varieties from damage as well as the efficacy of new organically approved chemical control options.